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Pollen and Macrofossil Study of an Interglacial Deposit in Nova Scotia
Étude du pollen et des macrofossiles d'un dépôt interglaciaire en Nouvelle-Écosse
Исследование пыльцы и макроископаемых остатков межледникового отложения в Новой Мотландии

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Résumé de l'article

L'enlèvement des formations superficielles, lors d'excavations dans la carrière de gypse d'East Milford en Nouvelle-Ecosse, a mis à jour 2 m de tourbe et d'argile organique compactées et déformées, ainsi que d'abondants restes végétaux, associés à des argiles et sables inorganiques et laminés. Les sédiments non glaciaires reposaient sur un dépôt gris ayant l'apparence de till et étaient recouverts par une couche de plus de 20 m de till rouge. Du bois met de la séquence. Des restes de bois, de graines et de mousses de > 50 000 ans BP (GSC-1642). L'analyse pollinique des sédiments organiques montre à la base un assemblage caractérisé par du pollen provenant de divers genres de feuillus, dont Fagus, Ulmus, Acer, Quercus et Tilia. Le pollen de Betula augmente vers le haut dans la séquence et devient le type dominant. Dans la partie supérieure de la séquence organique, Picea et Abies balsamea remplacent les bois durs. Alnus est le type de pollen le plus abondant au sommet de la séquence. Des restes de bois, de graines, de mousses et de Coléoptères aident à reconstituer l'environnement. Dans l'ensemble, les preuves permettent de conclure que la séquence date de la dernière partie d'un interglaciaire, probablement le Sangamonien. Les forêts de feuillus, dominées par une variété de genres thermophiles, témoignent d'un climat au moins aussi chaud que le climat actuel dans la région. À mesure que le climat s'est détérioré, les Betula ont proliféré. Le refroidissement continu a provoqué une transition vers les forêts de conifères dans lesquelles ont prédominé Picea et Abies balsamea.

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POLLEN AND MACROFOSSIL STUDY OF AN INTERGLACIAL DEPOSIT IN NOVA SCOTIA

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ABSTRACT Overburden removal for quarrying operations at the Milford Gypsum Quarry, East Milford, Nova Scotia, exposed 2 m of compacted and distorted peat and organic clays with abundant plant remains, associated with inorganic and laminated clays and sands. The nonglacial sediments were underlain by a grey till-like deposit and overlain by more than 20 m of red till. Wood (*Larix* sp.) from the nonglacial sediments produced a radiocarbon date of >50,000 years BP (GSC-1642). Pollen analysis of the organic sediments shows a basal assemblage characterized by a variety of hardwood pollen genera including *Fagus, Ulmus, Acer, Quercus* and *Tilia*. Higher in the sequence *Betula* pollen increases and becomes the dominant pollen type. Towards the upper part of the organic unit, *Picea* and *Abies balsamea* replace the hardwood genera. *Alnus* is the most abundant pollen type at the top of the sequence. Wood, seeds, moss and Coleoptera remains add to the environmental reconstruction. The evidence as a whole leads to the conclusion that the latter part of an interglacial interval, probably the Sangamon, is represented. Hardwood forests dominated by a variety of thermophilous hardwood genera attest to a climate at least as warm as the present in the area. As the climate deteriorated, *Betula* became dominant. Continued cooling induced a transition to coniferous forests in which *Picea* and *Abies balsamea* predominated.

RÉSUMÉ *Étude du pollen et des macrofossiles d'un dépôt interglaciaire en Nouvelle-Écosse.* L'enlèvement des formations superficielles, lors d'excavations dans la carrière de gypse d'East Milford en Nouvelle-Écosse, a mis à jour 2 m de tourbe et d'argile organique compactées et déformées, ainsi que d'abondants restes végétaux, associés à des argiles et sables inorganiques et laminés. Les sédiments non glaciaires reposaient sur un dépôt gris ayant l'apparence de till et étaient recouverts par une couche de plus de 20 m de till rouge. Du bois met de la séquence. Des restes de bois, de graines, de mousses et de de >50 000 ans BP (GSC-1642). L'analyse pollinique des sédiments organiques montre à la base un assemblage caractérisé par du pollen provenant de divers genres de feuillus, dont *Fagus, Ulmus, Acer, Quercus* et *Tilia*. Le pollen de *Betula* augmente vers le haut dans la séquence et devient le type dominant. Dans la partie supérieure de la séquence organique, *Picea* et *Abies balsamea* remplacent les bois durs. *Alnus* est le type de pollen le plus abondant au sommet de la séquence. Des restes de bois, de graines, de mousses et de Coléoptères aident à reconstituer l'environnement. Dans l'ensemble, les preuves permettent de conclure que la séquence date de la dernière partie d'un interglaciaire, probablement le Sangamonien. Les forêts de feuillus, dominées par une variété de genres thermophiles, témoignent d'un climat au moins aussi chaud que le climat actuel dans la région. À mesure que le climat s'est détérioré, les *Betula* ont proliféré. Le refroidissement continu a provoqué une transition vers les forêts de conifères dans lesquelles ont prédominé *Picea* et *Abies balsamea*.

РЕЗЮМЕ *Исследование пыльцы и макроископаемых остатков межледникового отложения в Новой Шотландии.* При удалении покрывающей породы на разработках карьера Милфорд Джипсум, Восточный Милфорд, Новая Шотландия было обнаружено 2 м спрессованного и деформированного торфа и органических глин с многочисленными остатками растений, связанных с неорганическими отслоениями глин и песчанников. Под неледниковыми отложениями лежали отложения серой валунной глины, а под ними более 20 м красной валунной глины. По древесине (Larix sp.) из неледниковых отложений удалось определить с помощью радиоактивного углерода возраст 50 000 лет до настоящего времени номер даты в Геол. управлении Канады GSC-1642 . Анализ пыльцы органических отложений показывает базальное скопление, характеризующееся различными видами пыльцы деревьев лиственных пород, включая Fagus, Ulmus, Acer, Quercus и Tilia. Выше в этой последовательности количество пыльцы Betula увеличивается и она становится преобладающим видом. В более высокой части органического пласта Picea и Abies balsamea вытесняют виды деревьев лиственных пород. Alnus является наиболее распространенным видом на самом верху этой последовательности. Все эти данные в целом приводят к заключению, что высшая часть пласта представляет собой позднейшую часть межледникового периода, возможно, сангамон. Леса из деревьев лиственных пород, в которых преобладали теплолюбивые виды лиственных деревьев, свидетельствуют о климате, по крайней мере таком же теплом, как настоящий климат в этом районе. По мере похолодания Betula стала преобладающим видом. Продолжающееся похолодание создало условия для преобладания хвойных лесов, в которых Picea и Abies balsamea стали наиболее распространенными видами деревьев.

INTRODUCTION

The complex glacial history of Atlantic Canada is still not completely understood, but the general sequence of Wisconsin Glaciation has been summarized by GRANT (1977). At the close of the Sangamon Interglacial, ice built up locally from various centres throughout the Maritime Provinces. A strong glaciation from the north subsequently passed over the region in early Wisconsin time. Retreat followed during middle Wisconsin time, and two subsequent readvances were from local centres of outflow once again.

Numerous buried nonglacial deposits containing organic remains, including several that predate the Classical Wisconsin Glaciation, have been found giving evidence of invasion of the region by plants and animals during past interglacial and/or interstadial intervals. Along the southwestern coast of Nova Scotia, marine shells dating 38,600 ± 1300 years BP (GSC-1440) (GRANT, 1971b), and on Cape Breton Island marine shells dating 32,100 ± 900 years BP (GSC-1048) (GRANT, 1971a), along with mastodon bones 31,900 ± 630 years old (GSC-1220) (PREST, 1977) attest to a mid-Wisconsin Interstadial interval. To date, plant remains of this age have not been found.

However many sites containing plant remains that produced infinite dates, some of which have been studied palynologically, have been found. MOTT and PREST (1967) reported on four sites on Cape Breton Island that contained pollen and spores indicative of boreal forest conditions suggesting a much cooler climate prevailed. These sites at Hillsborough, Whycocomagh and Bay St. Lawrence produced ages of more than 51,000 years BP (GSC-370), more than 44,000 years BP (GSC-290) and more than 38,300 years BP (GSC-283), respectively. The infinite dates and implied cool climate led to a tentative correlation with the St. Pierre Interstadial interval of Québec (TERASMAE, 1958). The Hillsborough site was also included in a study of interglacial and postglacial sites from eastern Canada by LIVINGSTONE (1968).

Several other buried organic sites on Cape Breton Island have also been studied. Two sites bordering Bras D'Or Lake produced radiocarbon dates of more than 42,000 years BP (GSC-1577) (GRANT, 1972) and more than 52,000 years BP (GSC-1619) (GRANT, 1977) but did not contain suitable material for pollen study. Near River Inhabitants, a buried organic layer dating more than 49,000 years BP (GSC-1406-2) yielded a boreal forest type pollen assemblage suggesting an interstadial interval possibly correlative with the sites noted above (MOTT, 1971). At Leitches Creek, two layers of compressed peat were encountered in a borehole through Quaternary sediments. The upper layer produced a radiocarbon date of more than 52,000 years BP (GSC-2678) with a pollen assemblage dominated by boreal forest indicators. The lower layer also contained boreal forest indicators but had more abundant pollen of thermophilous hardwood genera. The upper layer appears to be correlative with the previously described interstadial sites, whereas the lower unit may represent an interglacial interval (MOTT, 1973).

On mainland Nova Scotia three sites have produced infinite dates, and one such date has been obtained from a site in New Brunswick. At the latter site, mastodon bones dated at 13,600 ± 200 years BP (GSC-1222) were associated with peat having a date of more than 43,000 years BP (GSC-1680) (GRANT, 1977). Pollen analysis revealed an assemblage similar in some ways, but not analogous to late-glacial or postglacial assemblages from New Brunswick. Therefore, some doubt exists as to the correct age of this peat. At the Miller Creek Gypsum Quarry site in south-central Nova Scotia, organic sediment showing a *Pinus* pollen-dominated boreal forest spectrum (Mott, unpublished GSC Palynological Report No. 78-10) was originally dated at 33,200 ± 2000 years BP (I-3237) (MacNEILL, 1969), but was redated at more than 52,000 years BP (GSC-2694). STEA and HEMSWORTH (1979) believe the stratigraphy and pollen assemblage indicate the Sangamon Interglacial is represented. A similar finite age of 33,700 ± 2300 years BP (I-3236) was obtained from an intertill layer at Addington Forks (MacNEILL, 1969) but this sample was also redated at more than 42,000 years BP (GSC-1598) (PREST, 1977). The contained pollen assemblage of the intertill layer suggests a mixed hardwood forest dominated by oak existed at the time and indicates a warm interglacial interval.

However, the most interesting and productive site discovered thus far has been the National Gypsum Company Quarry near East Milford, Nova Scotia, where organic-bearing sediments have been uncovered on more than one occasion in the past as a result of overburden removal for quarrying purposes. PREST (1970) reported on a sinkhole deposit studied by W. Take of the Nova Scotia Museum. The deposit was reported to have contained numerous non-glacial sediment layers with abundant fossil plant remains representing more than one interglacial interval separated by glacial sediments. Unfortunately, no palynological studies were attempted, and the site was subsequently destroyed by quarrying. In 1975 other organic sediments were uncovered during overburden removal. Sections exposed in a trench excavated in the organic sediments were examined and collections were made by R.G. Grantham of the Nova Scotia Museum and E. Nielsen of Dalhousie University. Three profiles from different parts of the trench were sampled and numerous bulk samples of the upper peaty layers were collected; it is these samples that comprise this report.

SITE LOCATION AND STRATIGRAPHY

The East Milford Gypsum Quarry of the National Gypsum Company (Lat. 45°00′30″ N; long. 63°25′00″W) is located about 42 km NNW of Halifax, Nova Scotia (Fig. 1). The gypsum is quarried in an open pit operation from the Windsor Group of sediments of Mississippian age. The uneven karst topography of the gypsum is overlain by glacial and nonglacial sediments that are removed before quarrying operations proceed. More than 20 m of till had been removed in 1975 when organic sediments were encountered. A power shovel was then used to dig a trench up to 3 m deep and 20 m long through the nonglacial sediments (Fig. 2)

The trenching revealed the stratigraphy shown on the diagram of the south wall of the trench (Fig. 3). The uneven gypsum bedrock surface is visible at both ends

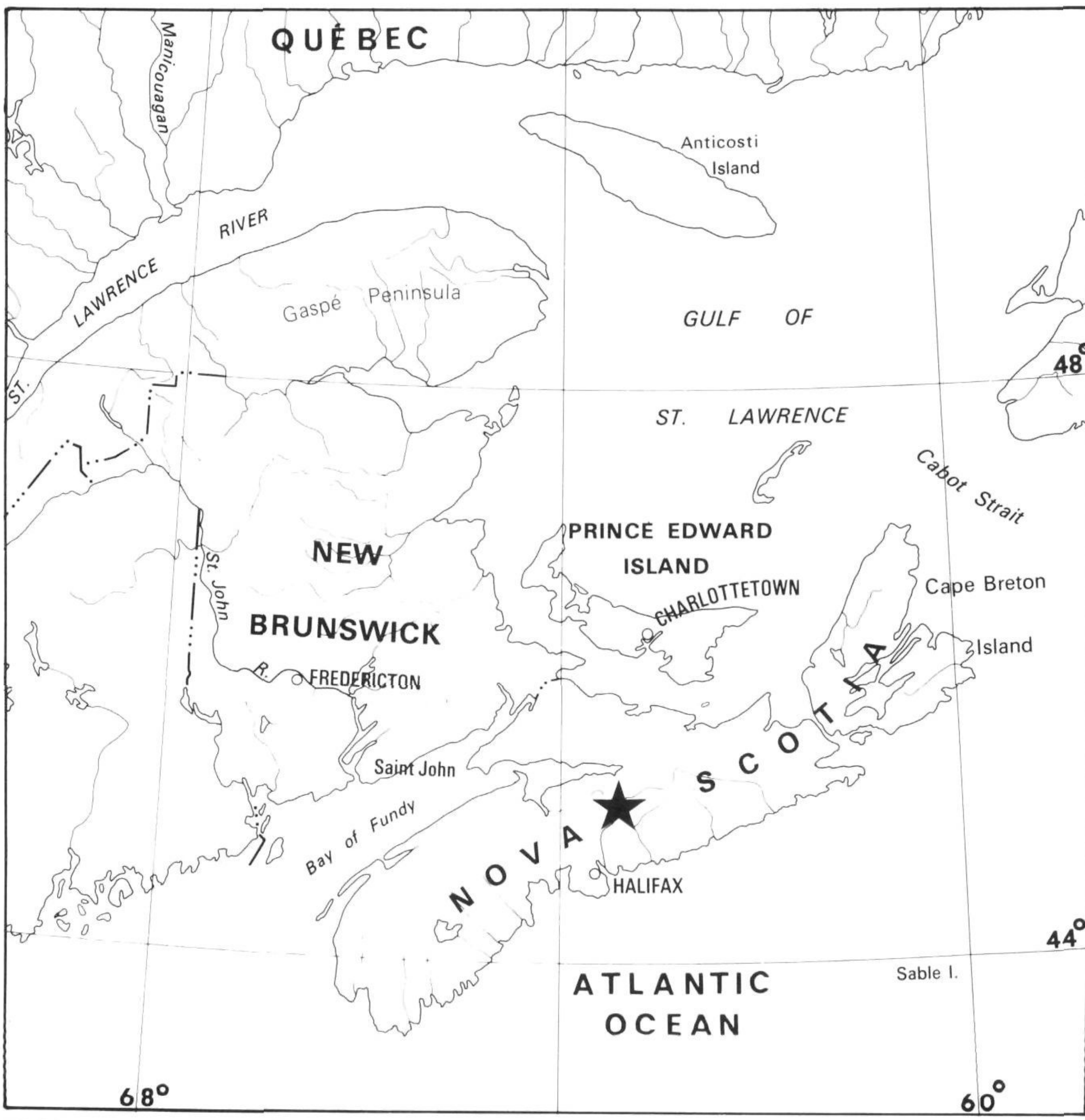


FIGURE 1. Location map showing East Milford Gypsum Quarry (Star). *Carte de localisation. L'étoile indique le site de la carrière de gypse d'East Milford.*

of the trench, although the overlying sediments do not appear to have been laid down in a karst depression. In the central part of the trench, a laminated, red and grey sand and silt of undetermined thickness is overlain by a gravelly, grey clay rubble, probably a till. The bedrock surface at the eastern end of the trench is overlain by red clay with pebbles and cobbles that grades into red clay with some granular material. The red clay at the eastern end has an irregular contact with, and grades into, an overlying grey clay, which in the central and western part of the trench forms an irregular contact with the gravelly, grey clay rubble. Some gypsum pebbles are present in the grey clay.

FIGURE 2. Trench through organic sediments diagrammed in Figure 3. Nova Scotia Museum photo.

Tranchée dans les sédiments organiques illustrés dans la figure 3. Photographie du Musée de la Nouvelle-Écosse.

Black organic clay with an irregular, deformed, gradational contact overlies the grey clay, and inclusions and seams of grey clay occur within the black clay. The black clay contains abundant wood and other organic remains especially towards the top of the unit where compact, fissile, coarse and woody peat occurs. One piece of *Larix* wood was radiocarbon-dated at more than 50,000 years BP (GSC-1642) (PREST, 1977). Towards the eastern end of the trench, the black clay and peat form thin seams within grey clay, however, whether or not these seams are continuous with the upper peat of the central part of the trench could not be determined with certainty. The north wall showed the upper peat thinning to the east and overlain by a seam of grey clay that either joins the lower organic horizon, or truncates it as if the upper seam was thrust overtop by pressure of the overriding ice. Red bouldery till and red laminated clay overlie the organic sediments at the eastern end of the trench.

The compact peat, deformed beds and contacts, inclusions of underlying with overlying units, and the thrusted appearance of the red, grey and black clays suggest deformation and thrusting of these units during emplacement of the overlying till. How much of the upper organic sediment was removed by the ice from some parts of the sequence, or how the thrusted appearing organic seam at the eastern end of the trench is related to the main sequence, is not known for certain. However, the organic and clay sediments all appear to be the same unit with any discontinuities being caused by deformation or erosion by the overriding ice; there does not appear to be two distinct nonglacial intervals involved.

Samples from Sections "B" and "C" were analysed for pollen, plant macrofossils and Coleoptera remains. Section "A", which was collected from near the western end of the trench, duplicated Section "B" and was

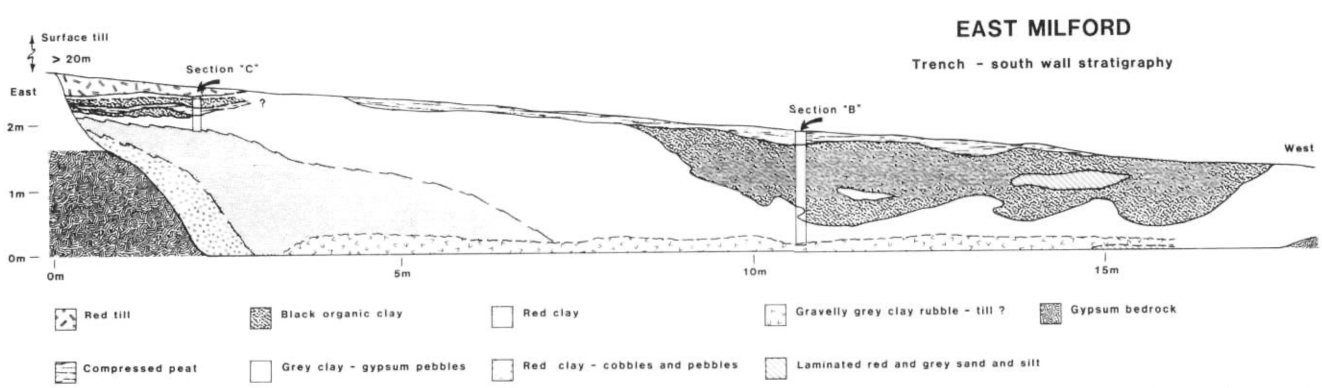


FIGURE 3. Stratigraphic section of south wall of trench shown in Figure 2, showing location of Sections "B" and "C".

Coupe stratigraphique de la paroi sud de la tranchée montrée dans la figure 2. La localisation des coupes "B" et "C" est indiquée.

not analysed. Two bulk samples of the upper peat layer were also examined for plant and insect fossils. Wood for identification was extracted from several bulk samples of woody clay and peat.

VEGETATION

The present day forest cover of the region, or at least the forest cover prior to its decimation for agriculture and forestry purposes was a mixture of coniferous species and tolerant hardwoods. ROWE (1972) classifies the area within the Central Lowlands Section of the Acadian Forest Region. LOUCKS (1962) includes the forests within the Windsor-Truro District of the Maritime Lowlands Ecoregion, a subdivision of the Red Spruce-Hemlock-Pine Zone.

White, red and black spruce *(Picea glauca, P. rubens P. mariana)*, balsam fir *(Abies balsamea)*, white birch *(Betula papyrifera)*, red maple *(Acer rubrum)*, hemlock *(Tsuga canadensis)* and white pine *(Pinus strobus)* with a scattering of sugar maple *(Acer saccharum)*, beech *(Fagus grandifolia)* and yellow birch *(Betula alleghaniensis)* comprise the dominant mixture. The latter tolerant hardwoods are more typical of low ridges and higher slopes and uplands and form the characteristic species of the adjacent Sugar Maple-Yellow Birch-Fir Zone of the higher regions to the south. Red oak *(Quercus rubra)* and white ash *(Fraxinus americana)* are common associates. Grey birch *(Betula populifolia)*, white birch, trembling aspen *(Populus tremuloides)*, red maple, white pine and spruce are prevalent on burned areas. White elm *(Ulmus americana)* and black ash *(Fraxinus nigra)* occur along river valleys. Black spruce and tamarack *(Larix laricina)* are common on boggy areas.

CLIMATE

Although Nova Scotia is almost completely surrounded by the sea, the province has a continental type climate, except locally along the coasts where the sea does exert some influence (HARE and THOMAS, 1974). This continentality is caused by the prevailing circulation of continental airmasses from the west with converging storm tracks moving eastward over the region. However, easterly circulations from the ocean are not uncommon. The mean annual temperature of the East Milford area is about 6°C, and the mean total precipitation is about 1300 mm. Snowfall is abundant averaging about 200 cm per year, but considerable melting can occur between snowfalls. Prevailing winds are from the southwest in summer and from the northwest the rest of the year. Climatic details were obtained from published data (THOMAS, 1953; METEOROLOGICAL BRANCH, 1960, 1968).

RESULTS

PALYNOLOGY

The results of palynological analysis are shown on the pollen diagram (Fig. 4). Pollen percentages are based on a sum which includes all pollen taxa except aquatics and does not include spores. Preservation was excellent in the peaty samples from Section "C" and in the bulk peat sample. Preservation was not good in the upper part of the Section "B" profile, with the palynomorphs somewhat corroded and compressed. Preservation became progressively poorer with depth, and below 80 cm from the base of the profile the pollen content was very poor. The few palynomorphs present were badly corroded and barely discernable. However, Polypodiaceous fern spores were extremely abundant, and although darkened and slightly corroded they were obviously not affected to the same degree as most palymorphs are shown. For convenience of discussion, four and very low counts in this part of profile "B", percentages were not calculated and only numbers of palynomorphs are shown. For convenience of discussion, four pollen assemblage zones have been delineated in the Section "B" profile based on the dominant pollen types and are numbered consecutively upwards.

Above the basal sediment containing the poorly preserved palynomorphs, the sediments contain pollen assemblages dominated by such hardwood- taxa as *Fagus grandifolia* (beech), *Tilia* (basswood) and small values of *Quercus* (oak), *Carya* (hickory), *Ulmus* (elm) and *Acer* (maple) (Zone 1). These hardwood genera in one sample represent 39 percent of the pollen sum. *Lycopodium* (clubmoss) spores are abundant, especially *L. lucidulum* type, along with Polypodiaceous (Polypodiaceae) fern spores. *Betula* (birch) pollen is relatively abundant at about 20 percent. Coniferous taxa are not abundant, but small percentages of *Picea* (spruce), *Pinus* (pine) and *Abies balsamea* (balsam fir) are present. Gramineae (grass) and Tubuliflorae are two of the otherwise very few herbaceous pollen taxa present.

In Zone 2, about 100 cm below the top of the trench, *Betula* pollen increases considerably and remains abundant for an interval of 40 cm. The other more thermophilous genera, which were abundant below, decline, and *Picea* and *Abies balsamea* increase slightly. Polypodiaceae spores remain abundant.

Betula pollen declines considerably in Zone 3, and *Abies balsamea* becomes plentiful followed by an increase in *Picea* pollen. Hardwood pollen genera decrease further in abundance as do the Polypodiaceae spores. *Abies balsamea* values are variable to the top of the section, whereas *Picea* pollen exceeds 20 percent only to the top of Zone 3 where it declines as *Alnus* (alder) pollen increases greatly. *Populus* (poplar or

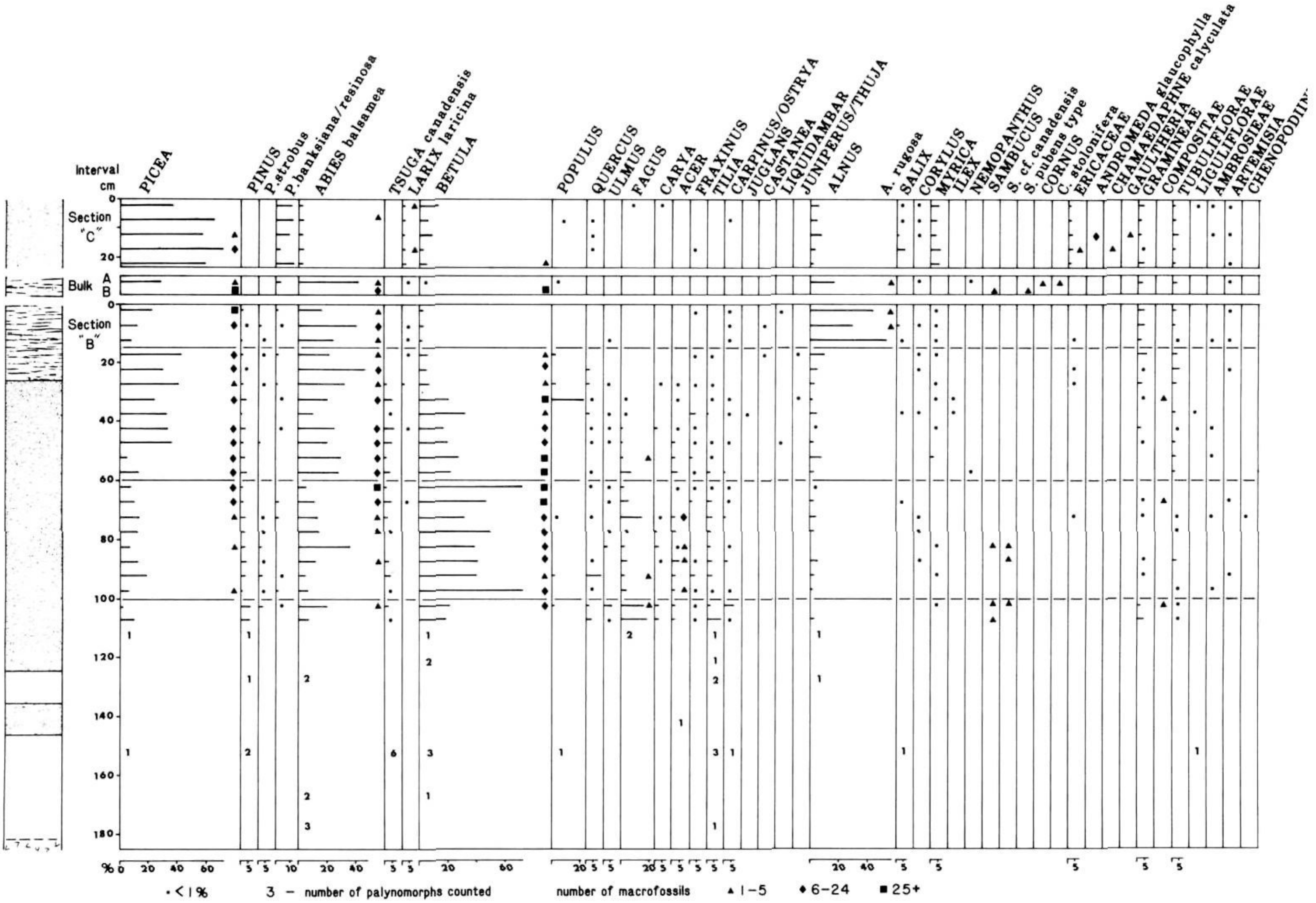


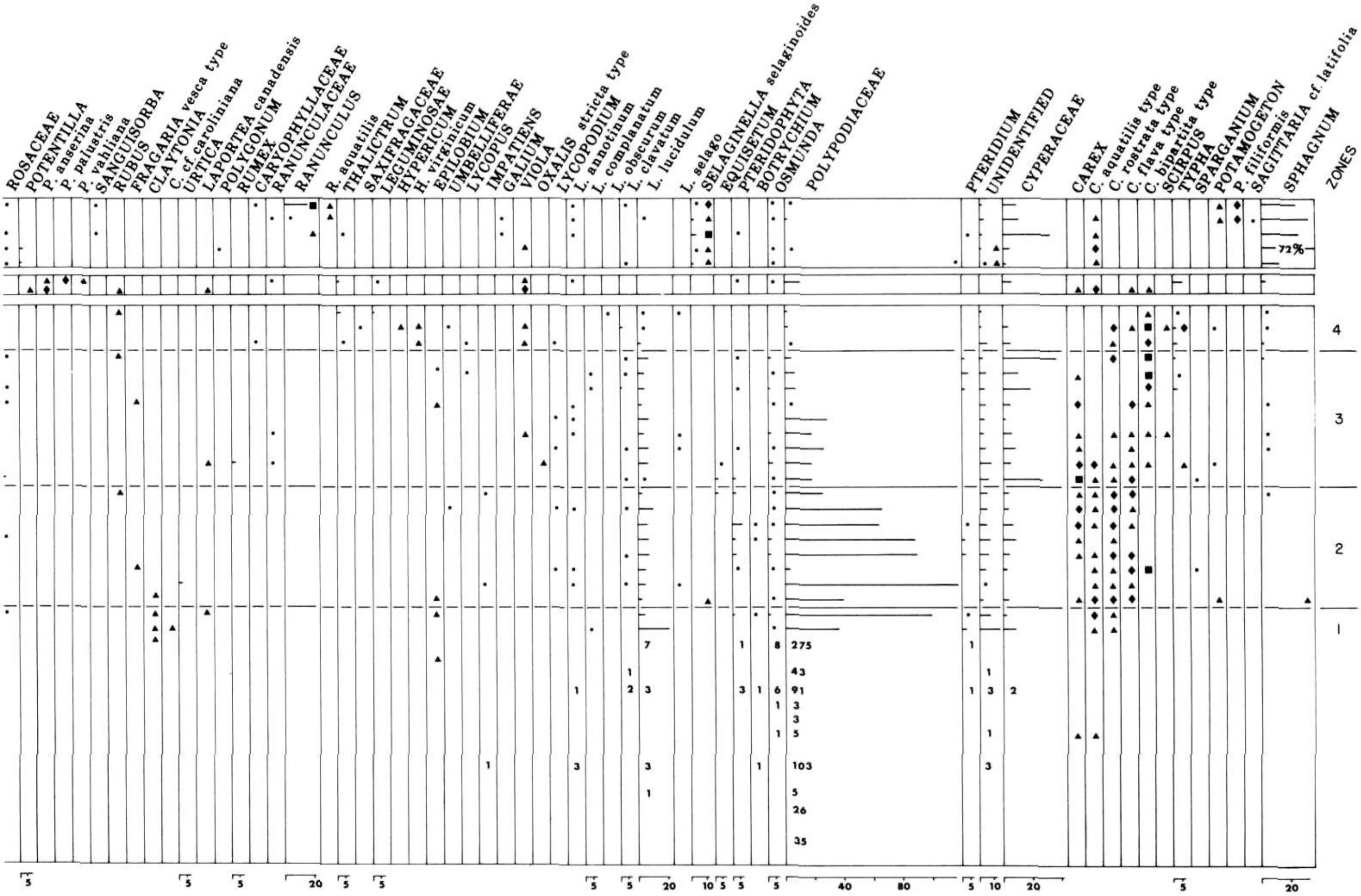
FIGURE 4. East Milford pollen and plant macrofossil diagram.

Diagramme du pollen et de la macro-flore, site d'East Milford.

aspen) pollen values exceed 20 percent at the 30 cm level where *Betula* values decline to very low values. The single large value for *Populus* is difficult to assess because of the notoriously poor preservation of *Populus* pollen. Since pollen preservation is generally poor in this section, *Populus* may have been more abundant at other levels but was not preserved. With the increase in *Picea* and *Abies* pollen, the hardwood genera not only decline in abundance but in variety as well. Shrub and herb pollen taxa increase and fern and *Lycopodium* spores decline in numbers. Cyperaceae (sedge) pollen and other aquatic taxa are more prevalent, and *Sphagnum* spores increase slightly.

Alnus pollen, which is almost exclusively of the *Alnus rugosa* type, dominates and characterizes Zone 4. *Picea* pollen is less abundant but *Abies balsamea* is still very plentiful. *Betula* values are very low as are hardwood pollen types generally.

The bulk "A" peat sample has a similar pollen assemblage to the upper part of the profile from Section "B", however, the spectra recovered from Section "C" are considerably different. *Picea* pollen is extremely abundant, varying from 37 to 64 percent. *Abies balsamea* values are low as are *Betula* and other hardwood genera. *Alnus* pollen values are also low, and the grains are of the *Alnus crispa* type in contrast to the *Alnus rugosa* type of Section "B". *Salix* (willow) and *Myrica* pollen are present along with small but continuous values of Ericaceae. *Ranunculus* pollen is abundant in the uppermost sample. A variety of herbs ar represented by small amounts of pollen. Among the spores, *Selaginella selaginoides* is the most abundant. Cypera-



ceae pollen is plentiful and *Sphagnum* spores are very abundant reaching a high of 72 percent.

PLANT MACROFOSSILS

Plant macrofossils recovered from Sections "B" and "C" and from the bulk peat sample are shown on the pollen diagram (Fig. 4) as symbols on the right-hand side of the columns. Varying symbols are employed simply as a means of indicating the relative abundance of the various taxa. Small triangles represent 5 macrofossils (seeds, leaves, etc.) or less; diamonds represent 6-24 macrofossils; and squares 25 macrofossils or more.

Macrofossil recovery from the lowest 70 cm of Section "B", as with the pollen, was very low. The only macrofossils recovered include a conifer needle from a depth of 140 cm, a *Carex aquatilis* achene and an undifferentiated *Carex* achene from 135 cm depth, and a poorly preserved seed resembling *Epilobium angustifolium* from 115 cm depth. Charcoal fragments are abundant throughout the complete lower segment of the section. Needles and seeds of *Picea glauca* and *P. mariana* occur in Zones 2, 3 and 4 and become abundant near the top of the section. *Abies balsamea* needles and seeds are present in Zone 1 and the base of Zone 2, but become fairly abundant higher in the section as well. *Betula* fruits, some of which were identified as *Betula alleghaniensis,* are present in Zone 1, become abundant in Zones 2 and 3 and disappear in Zone 4. Nuts of *Fagus grandifolia* were recovered from two samples in Zones 1 and 2 and from the base of Zone 3 where *Fagus* pollen begins to decline. Terminal buds that appear similar to those of *Acer* were found in Zone 2. Fruits comparable to those of *Alnus rugosa* occur in Zone 4 where *Alnus* pollen is abundant. *Carex* achenes are the only other plant macrofossils in continuous abundance throughout the productive segment of the section. *Carex aquatilis, C. rostrata, C. flava* and *C. bipartita* types are the dominant species represented along with undifferentiated *Carex* and *Scirpus* achenes. Seeds of *Typha* and *Potamogeton* occur sporadically.

Several other taxa are represented by lesser numbers of macrofossils dispersed throughout the palynologically productive part of Section "B". *Sambucus* cf. *canadensis, Claytonia* cf. *caroliniana* and *Laportea canadensis* are more characteristic of Zones 1 and 2, whereas *Hypericum virginicum, Rubus, Fragaria vesca* type, *Viola* and *Oxalis* seeds occur mainly in Zones 3 and 4.

Plant macrofossils found in the bulk "A" peat sample include *Picea glauca* type seeds, *Abies balsamea* needles, and fruits of *Alnus rugosa* type, *Cornus stolonifera, Viola, Potentilla anserina, P. palustris* and *P.* cf. *vahliana*. The bulk "A" peat was also examined for bryophytes, and to date, four species have been recovered and identified by J.A. Janssens (Bryological Report JJ 413, 1980); they are *Calliergon giganteum, Mnium cinclidioides, Polytrichum juniperinum* and *Sphagnum teres*. A second bulk peat sample, identified on Figure 4 as bulk "B", was not examined for pollen but plant macrofossils were recovered. Taxa identified include those found in the upper part of Section "B" with the exception of *Hypericum* and the presence of *Sambucus, Potentilla, Laportea canadensis* and *Selaginella selaginoides*.

The upper part of the black clay unit and the peaty sediment near the top of Section "B" also contained abundant pieces of wood, some of which were very large. Of twenty pieces of wood examined, six were identified as *Picea* sp. and fourteen as *Abies balsamea*. The wood sample used for radiocarbon dating was *Larix* sp.

The five samples examined from Section "C" contained numerous plant macrofossils of various types (Fig. 4). Needles and seeds of *Picea mariana* and *Larix laricina*, a needle of *Abies balsamea*, achenes of *Carex aquatilis*, and macrospores of *Selaginella selaginoides* were found. *Ranunculus* sp. seeds were plentiful in some samples along with *Ranunculus aquatilis* and such bog flora representatives as *Chamaedaphne calculata, Andromeda glaucophylla* and *Gaultheria* sp. Aquatic plant seeds found include *Potamogeton* cf. *filiformis* and other species of *Potamogeton*. Moss remains including *Sphagnum* were abundant.

TABLE I

Taxon	Sect. B	Bulk. "A"	Sect. C
COLEOPTERA			
Carabidae (ground-beetles)			
Sphaeroderus lecontei Dej.	65-70		
Bembidion sp. A	100-105		
Bembidion sp. B	70-75		
Bembidion sp. C		+	
Trechus sp.		+	
Agonum mannerheimi Dej.			20-25
Pterostichus cf. *P. adstrictus* Eschz.		+	
P. patruelis Dej.			10-15
P. (Cryobius) sp.			15-20
Pterostichus sp.		+	
Dytiscidae (predaceous diving beetles)			
Agabus (?) sp.		+	
Genus?	55-60	+	
Hydrophilidae (water scavenger beetles)			
Helophorus sp.			10-15
Genus?		+	
Staphylinidae (rove beetles)			
Tachinus sp.	0-5 60-65		
Tachyporus sp.			15-20
Olophrum sp.	20-25		
Acidota sp.			15-20
Omalinae undet.			20-25
Gymnussa sp.			;15-20
Aleocharinae undet.	20-25		
Lathrobium sp.	55-60		
Quedius sp.		+	
Stenus sp.			5-10 15-20
Pselaphidae			
Genus?		+	
Hydraenidae			
Hydraena sp.	5-10		
Byrrhidae (pill beetles)			
Genus?	55-60		
Chrysomelidae (leaf beetles)			
Donacia sp.	55-60	+	
Genus?		+	
Curculionidae (weevils)			
Genus?	55-60		
Scolytidae (bark beetles)			
Genus?	60-65		
DIPTERA			
Larval and puparial fragments		+	
HYMENOPTERA			
Formicidae (ants)			
Genus?			15-20
HETEROPTERA			
Undetermined fragments	30-35		

Number refers to depth in cm at various sections shown in Fig. 4. See also Fig. 4 for location of Bulk "A" sample. + = present.

ARTHROPODS

Arthropod remains are not abundant in samples from Sections "B" and "C" nor in the bulk peat samples. Most of those that were recovered (Table I) represent

Coleoptera (beetles), and as is usually the case, the most readily identified specimens were pronota, heads and elytra of ground-beetles (Carabidae). In addition to carabids the table includes several types of aquatic or near-aquatic beetles, as well as some that are associated with particular types of plants. The general paucity of fossils, especially the low abundance of specifically identified specimens, severely limits the paleoenvironmental resolving power of the insect assemblages.

INTERPRETATION

The stratigraphic sequence and lithology of the sediments in the trench indicate deposition of clayey sediment followed deglaciation and early reworking of glacial deposits. The gray clay is essentially barren of palynomorphs and macrofossils indicating deposition in a basin in a poorly vegetated environment. In fact, deposition may have preceded the incursion of vegetation into the area following deglaciation. Organic matter gradually began to accumulate on this clayey surface possibly in a wet depression and black clay was deposited. Unfortunately, this environment was not suitable for palynomorph preservation as indicated by the small numbers of pollen grains and spores present, most of which are poorly preserved. Polypodiaceous fern spores are the only abundant grains along with smaller amounts of other fern and *Lycopodium* spores. Tree pollen is very meagre and herbaceous types are absent making interpretation difficult. The site may have been a treed swamp with little standing water, a habitat poorly suited to organic preservation.

As black clay continued to accumulate, preservation was somewhat better and the pollen evidence indicates that a hardwood forest existed in the area. *Fagus grandifolia, Tilia* and *Acer* were prominent along with lesser amounts of other hardwood genera. Total thermophilous hardwood pollen genera in these assemblages exceed the same total in modern surface samples from Nova Scotia (J.G. Ogden III, personal communication). Some *Abies balsamea* was present but *Picea* and *Pinus* were not abundant if present at all. *Laportea canadensis, Claytonia* cf. *caroliniana* and *Sambucus* cf. *canadensis* commonly inhabit cool and moist sites in beech-maple forests adding support to the interpretation that a mature mixed hardwood forest prevailed in the area. *Laportea canadensis*, in particular, often covers the floor of *Acer rubrum-A. saccharinum* forests on humid, rich alluvial soils, and its large leaves inhibit all other vegetation growing underneath them (MARIE-VICTORIN, 1964). Lycopods and ferns of various types were common probably as the understory in a moist wooded environment. Sedges (Cyperaceae) were not plentiful but their presence probably indicates some wet areas. Aquatic genera were not represented indicating open water areas were not abundant. Charred wood and charcoal fragments suggest fire may have been a frequent occurrence in the area. *Bembidion*, the one ground-beetle recovered, is not diagnostic enough to add to the interpretation of Zone 1. From the above evidence it seems probable that a climate at least as warm as the present prevailed and a mixed hardwood forest covered the landscape.

Betula then increased in the surrounding forest with *Betula alleghaniensis,* and probably *Betula papyrifera* as well, being represented. Other hardwood genera declined somewhat in abundance, and *Abies balsamea* increased. The shrub and herbaceous taxa noted above persisted for some time indicating that environmental changes were not drastic and that the forest still had a deciduous character. Lycopods and ferns remained abundant and a few genera such as *Sparganium* and *Potamogeton* appeared indicating the presence of some open water bodies. However, the sparcity of aquatic beetles and the noteworthy absence of chironomid (Diptera) head capsules, normally abundant in open-water pond sediments, suggests that open-water bodies were not plentiful. Some insight into the local environment at the time represented by the upper part of Zone 2 can be obtained from the beetles recovered, particularly those identified to species. The groundbeetle *Sphaeroderus lecontei* is an eastern species, and though not recorded from Nova Scotia by LINDROTH (1961), it is expected there. It inhabits forests only as far north as the southern edge of the Boreal Forest today, commonly the moist sites near water where dead leaves and mosses accumulate beneath deciduous bushes (LINDROTH, 1961). The presence locally of trees is attested to by a few fossils of bark-beetles (Scolytidae) at this level also. Therefore, at the time represented by Zone 2, a distinctly hardwood forest persisted but with some conifers, especially *Abies balsamea*, present and a climate probably not unlike today in central Nova Scotia.

However, hardwood genera, including *Betula,* declined in abundance at the time represented by the base of Zone 3. *Abies balsamea* increased considerably and the forests must have shown a definite change to a more coniferous type. These changes persisted and *Picea,* both *P. glauca and P. mariana,* became more abundant along with *Abies balsamea,* and hardwood taxa became very sparse. The high pollen and macrofossil values of *Abies balsamea* indicate a very large representation of this species in the forests. *Populus* may have increased coincident with *Picea,* and *Larix laricina* appears at this time as well. Increased Cyperaceae, the occurrence of *Sphagnum,* and the decline in ferns and Lycopods attest to greater swampy and boggy conditions. Dytiscids (predaceous diving beetles), although rare, argue for some open-pond water at or near the site. The leaf beetle, *Donacia,* is a beetle of the emergent vegetation zone of ponds, whereas, *Lathrobium* (rove beetle) is more characteristic of soaked substrates back from the zone of emergent vegetation. The evidence all points to a trend towards boreal forest conditions with predominantly coniferous trees on uplands and increased boggy conditions in low areas, and a climate considerably cooler than had existed previously.

With time, the vegetation continued to change and *Alnus,* probably *A. rugosa,* became very abundant and *Picea* declined. *Betula* and other hardwoods were very sparse. *Alnus* probably proliferated around ponds and boggy areas. The moss peat at the top of the section containing such species as *Calliergon giganteum, Mnium cinclidioides, Polytrichum juniperinum* and *Sphagnum teres* point to continued paludification of the landscape. The few insect taxa represented in Zone 4, *Tachinus* sp. and *Hydraena* sp. are compatible with a wet, boggy environment. Obviously, the climate had cooled considerably, probably indicating the onset of glaciation that eventually deposited the overlying till. However, Section "B" is truncated and it is not known how much of the profile may have been removed by overriding ice.

Section "C" has pollen and macrofossil spectra that are distinctly different from Section "B". These differences may be accounted for in two ways. Section "C" may represent part of the time that is missing from Section "B", or conversely, it may represent an entirely different nonglacial interval. Despite some vagueness in the stratigraphy at the eastern end of the trench, a lengthy hiatus is not apparent as would be expected if a different nonglacial interval was represented in Section "C". Rather, the simpler explanation that the overriding glacier removed part of the sequence in places and not in others is more feasible. However, at the time of deposition of the sediments of Section "C", *Picea mariana* and *Larix laricina* were dominant conifer species. Other tree genera including *Betula* were poorly represented. The *Alnus* present was probably *Alnus crispa* and this species may have been present on the upland sites. Locally, Ericaceous plants including *Andromeda glaucophylla, Chamaedaphne calyculata* and *Gaultheria* were plentiful, as well as Cyperaceae and *Sphagnum,* attesting to the boggy character of the area. Such species as *Potamogeton filiformis,* a common northerly pond plant; *Ranunculus aquatilis,* a circumboreal pond and stream species; and *Carex aquatilis,* a common species of marshes and wet meadows in the north, occurred. The fossil insect fauna corroborate the existence of such an environment. Species of the genus *Gymnussa, Pterostichus patruelis, Agonum mannerheimi* and some species of *Stenus* are found in wet, boggy and marshy areas. *Agonum mannerheimi*, in particular, is very hygrophilous. It may be collected today by treading the almost floating vegetation of *Sphagnum* swamps. Although the species does occur in southern Ontario and the Montréal area (LINDROTH, 1966), it is predominantly northern in distribution and its failure to be recorded in any of the maritime provinces (LINDROTH, 1966) is probably an indication that it is not adapted for the climate of that region. The fossil referred to the subgenus *Cryobius* has a similar meaning, though if anything, the species of that group are even more northern in their distribution than *Agonum mannerheimi.* However, without knowing which *Cryobius* species is represented, the most that can be said is that the lowlands of Nova Scotia are definitely south of the present distribution of *Cryobius. Pterostichus patruelis* does occur in the northern part of Nova Soctia (Cape Breton Island) as well as in New Brunswick, but like the others mentioned above it is most common in the damp margins of ponds within the boreal zone. The micro — and macrofossils suggest a northern boreal environment for the East Milford region during the time of deposition of the sediments represented in Section "C", with a climate similar to that within the Boreal Forest today.

Judging from the evidence for at least part of the interval represented, an interglacial interval having a climate at least as warm as that of the same area of Nova Scotia today is inferred. As there is no evidence to suggest otherwise, then the interglacial interval is probably the Sangamon. The vegetation of the early part of the interval is not represented, the earliest flora being a mixed hardwood forest. Climatic conditions then began to deteriorate and the hardwood forest was replaced by mixed forest, which in turn changed to a coniferous forest.

CORRELATION

Several deposits in northeastern North America have been related to the Sangamon Interglacial. The Don Formation at Toronto, Ontario (KARROW, 1969; TERASMAE, 1960) is a classical sequence where floral evidence indicates a distinct deciduous forest being replaced by a coniferous forest. A similar hardwood forest is recorded by pollen from the "Fernbank" site in nearby northern New York State (BLOOM and McANDREWS, 1972). The Missinaibi Formation of northern Ontario was originally thought by TERASMAE (1960) to date from an early Wisconsin Interstadial based on the boreal forest character of the pollen spectra, but a subsequent study by SKINNER (1973) led to the conclusion that an interglacial interval, most likely the Sangamon, is represented. Coniferous pollen associated with some deciduous taxa, as well as a variety of macrofossils led PREST *et al.* (1976) to conclude that an interglacial interval is represented on the Magdalen Islands in the Gulf of St. Lawrence.

New radiocarbon dates by STUIVER *et al.* (1978) led them to postulate that the St. Pierre interval, originally interpreted as an early Wisconsin Interstadial by TERASMAE (1958) was, in fact, of interglacial age. However, the stratigraphy, palynology and fossil insects (Matthews, unpublished) favour Terasmae's interpretation.

Within Nova Scotia, the Addington Forks buried organics (PREST, 1977) and the lower peat layer at Leitches Creek (MOTT, 1973) are likely correlative with the East Milford interval and presumably Sangamon in age. STEA and HEMSWORTH (1979) have interpreted the organic sediment of the Miller Creek site as being interglacial based on the stratigraphy, although the pollen spectra are not similar to East Milford.

In light of the spectra dominated by coniferous pollen in the upper part of the profile at East Milford, the possibility exists that the buried organic sediments at several other sites in Nova Scotia represent the end of an interglacial interval rather than an interstadial interval as previously postulated. The East Milford spectra show that environmental conditions changed toward the close of the interval favouring the growth of peat. If such conditions were widespread, it is possible that the peat layers from other sites also accumulated at that time, and they may well be correlative.

Hopefully, sites representing a complete interglacial interval will be found in the future that will allow better correlation and understanding of the complete Quaternary history of the Maritimes.

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